

****Volume Title****

*ASP Conference Series, Vol. **Volume Number***

****Author****

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Astro-WISE processing of wide-field images and other data

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Abstract.

Astro-WISE¹ (Vriend et al. 2012) is the Astronomical Wide-field Imaging System for Europe (Valentijn et al. 2007). It is a scientific information system which consists of hardware and software federated over about a dozen institutes throughout Europe. It has been developed to exploit the ever increasing avalanche of data produced by astronomical surveys and data intensive scientific experiments in general.

The demo explains the architecture of the Astro-WISE information system and shows the use of Astro-WISE interfaces. Wide-field astronomical images are derived from the raw image to the final catalog according to the user's request. The demo is based on the standard Astro-WISE guided tour, which can be accessed from the Astro-WISE website.

The typical Astro-WISE data processing chain is shown, which can be used for data handling for a variety of different instruments, currently 14, including OmegaCAM, MegaCam, WFI, WFC, ACS/HST, etc².

1. Typical Data Processing Chain

Astro-WISE was originally designed to handle the large datasets from the OmegaCAM instrument such as the KiDS survey (Verdoes Kleijn et al. 2012). The backbone of Astro-WISE is set by the way it captures all science products obtained in survey operations in an object-oriented data model. Figure 1 shows the main astronomical classes in the Astro-WISE environment, the basic elements of the data processing chain. Each block is a class and each instance of a class is called a *Target*. The class incorporates a method to derive the data of the Target from other objects, called its *dependencies*.

The user has an ability to combine recipes in a pipeline to process the data by directly requesting the final required data product he or she is interested in. All processing parameters, along with the full data lineage, are saved in the metadata through the persistence of all objects. In the demo the user goes from a *RawScienceFrame* (raw frame observed by the VST and ingested in Astro-WISE) to a *SourceList* (the cata-

¹<http://www.astro-wise.org>

²http://www.astro-wise.org/portal/instruments_index.shtml

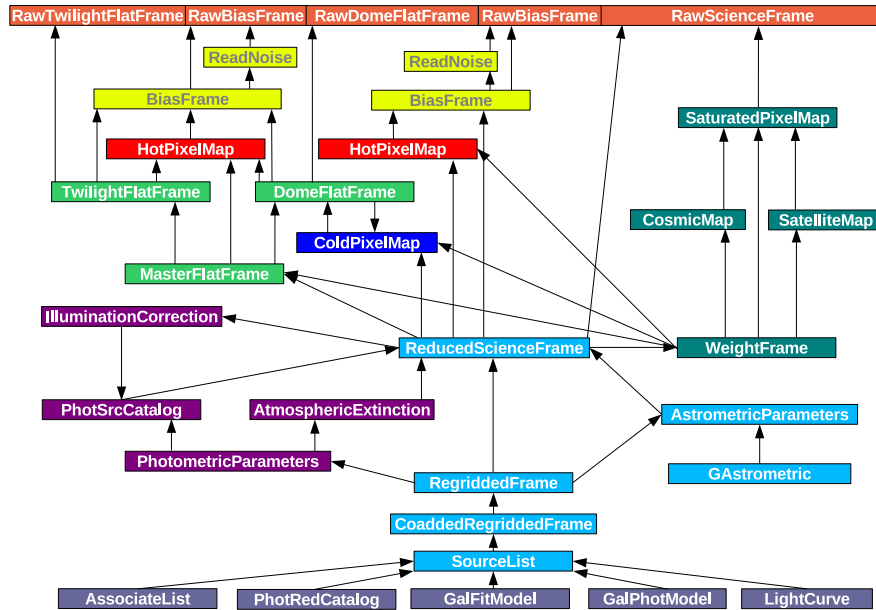


Figure 1. A *target diagram*: slightly simplified object model that is a view of the dependencies of “targets” to the ocean of raw observational data of astronomical wide-field imaging. The arrows indicate the backward chaining to the raw data, not the progression through any processing pipeline. The colors provide a visual grouping of similar types of data products.

log produced from reduced, regridded and coadded images)³, using the Astro-WISE infrastructure through the web services described below.

An Astro-WISE node is the building element of Astro-WISE infrastructure. It consists of data storage element (dataserver, which stores all the files with images), meta-data database (RDBMS, which keeps metadata including links between data items), computing elements (Distributed Processing Unit) and a number of interfaces and services which allow to the user to browse and process data stored in the system (see Begeman et al. (2010) for more technical details).

2. Services and Interfaces

The main language for the system is Python, but each user can develop her/his own application or use an existing application which can be wrapped into Python. Usually, users develop pipelines or workflows using existing “blocks” with the help of pre-defined Python libraries and classes. The user can also change an existing data model if necessary or implement a new one.

The Command Line Interface of Astro-WISE, AWE (Astro-WISE Environment), can be installed on a site without any other components of Astro-WISE (data server

³http://www.astro-wise.org/portal/howtos/man_howto_tutorial_science/man_howto_tutorial_science.shtml

and metadata database). Basically the AWE prompt is a link to a local Python installation with the Astro-WISE libraries and environments.

Apart from the AWE prompt, Astro-WISE supports a range of web interfaces. This makes it possible for a user to work with data stored in Astro-WISE without the AWE prompt using a web browser only. The web interfaces are divided into two types: data browsing/exploration and data processing/qualification. The first group includes:

- dbviewer⁴ – the metadata database interface which allows browsing and querying all attributes of all persistent objects stored in the system,
- Go-WISE⁵ – allows querying on a limited subset of attributes of the data model (coordinate range and object name), and provides results of all projects,
- image cut out service⁶ and color image maker⁷ – these two services are for the astronomical image data type and allows creation of cut-outs of an image or the creation of a pseudo-color RGB image from three different images of the same part of sky,
- skymap⁸ – exploration tool of the Astro-WISE system using the GoogleSky interface.

Data processing / qualification interfaces are:

- target processor⁹ – the main web tool to process the data in Astro-WISE. This web interface allows the user to go through pre-defined processing chains submitting jobs on the Astro-WISE computing resources with the ability to select the computing node of Astro-WISE. The Target Processor allows for implicit collaboration by indicating that objects can be reprocessed when another scientist has created improved versions of the objects that it depends on,
- quality service¹⁰ – allows the estimation the quality of the data processing and set a flag highlighting the quality of the data,
- CalTS¹¹ – web interface for qualifying and time stamping calibration data.

The exact set of web interfaces depends on the data model implemented in the system. The web interfaces described above are for the optical image data processing and follow the requirements for this particular data model and data processing chain. Astro-WISE allows the implementation of new web interfaces for the data model and for data processing defined by the user. The developer of the new web interface will use pre-defined classes and libraries of Astro-WISE to create it.

⁴<http://dbview.astro-wise.org>

⁵<http://gowise.astro-wise.org>

⁶<http://cutout.astro-wise.org>

⁷<http://rgb.astro-wise.org>

⁸<http://skymap.astro-wise.org>

⁹<http://process.astro-wise.org>

¹⁰<http://quality.astro-wise.org>

¹¹<http://calts.astro-wise.org>

3. Data publishing and External Data

Data access interfaces from the Virtual Observatory exist as separate services¹², that enables browsing the metadata database and retrieving the data from dataservers. Astro-WISE supports the Simple Image Access Protocol for images and ConeSearch for sources. Each data entity in Astro-WISE has a persistent attribute which shows scope of visibility for this entity, which allows the creator of the object to specify with whom to share the object.

4. Conclusion

The demo of Astro-WISE is based on the Astro-WISE guided tour and tutorial, which can be found on the Astro-WISE website. It shows how the request driven way of processing and full data lineage gives Astro-WISE the power to handle the large datasets produced by surveys such as KIDS. The user can apply standard data processing using target processing or can develop his/her own recipe for the data processing using the Astro-WISE pipeline as the building blocks.

Acknowledgments. Astro-WISE is an on-going project which started from a FP5 RTD programme funded by the EC Action “Enhancing Access to Research Infrastructures”. This work is supported by FP7 specific programme “Capacities - Optimising the use and development of research infrastructures”. This work is supported by Target¹³, a public-private R&D programme for information systems for large scale sensor networks.

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¹²http://www.astro-wise.org/portal/aw_vo.shtml

¹³<http://www.rug.nl/target>